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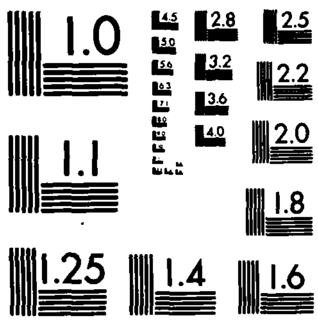

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REMOTE DATA ACQUISITION SYSTEM

by

Norman C. Poirier
Thomas P. Wheeler

NORTHEASTERN UNIVERSITY
360 Huntington Avenue
Boston, Massachusetts 02115

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents a description of a Remote Data Acquisition System developed under contract F19628-83-C-0037. The purpose of this system is to provide a means of acquiring data from scientific instruments and housekeeping functions on sounding rockets which due to their distance from the encoding system could present noise and transient pulse problems.

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1. INTRODUCTION

In applying the programmable PCM encoder developed during the previous contract F19628-80-C-0050, it was found that the sources of data in many cases were quite remote, spacially, from the encoder. Because of the long cable runs between sources and encoder, noise pick up becomes a non-trivial problem, especially with high impedance sources. This is also particularly true when the cables must pass near high noise producing environments such as DC to DC power converters, particle beam generators, and various active probes. Another related problem is that the multiple remote sources may require large bundles of cables which may not be able to pass through physically restrictive passages, such as some hermetically sealed instrument sections.

To alleviate the above mentioned problems, a general purpose Remote Data Acquisition System (RDAS) has been developed. The system has 64 analog inputs, self generated references, microprocessor controlled formatting, analog and digital outputs, balanced instrumentation amplifier input circuitry, and a high degree of input and output overvoltage and transient protection. Figure 1 is a block diagram of the system and Figure 2. is a detailed schematic diagram.

Three independant outputs are available from the RDAS. The first is a -1.25 to 5.00 volt PAM output which could be used to drive a subcarrier oscillator or the input of an analog channel on a PCM encoder. The second is also a PAM output generated from the first output by gain and level shifting to a 0.0 to 5.0 volt range. This output could be used to drive a miniature subcarrier oscillator whose band edge voltages are preset at the factory to 0 and 5 volts. (Otherwise a special order subcarrier oscillator with band edges set to -1.25 and 5.00 volts would

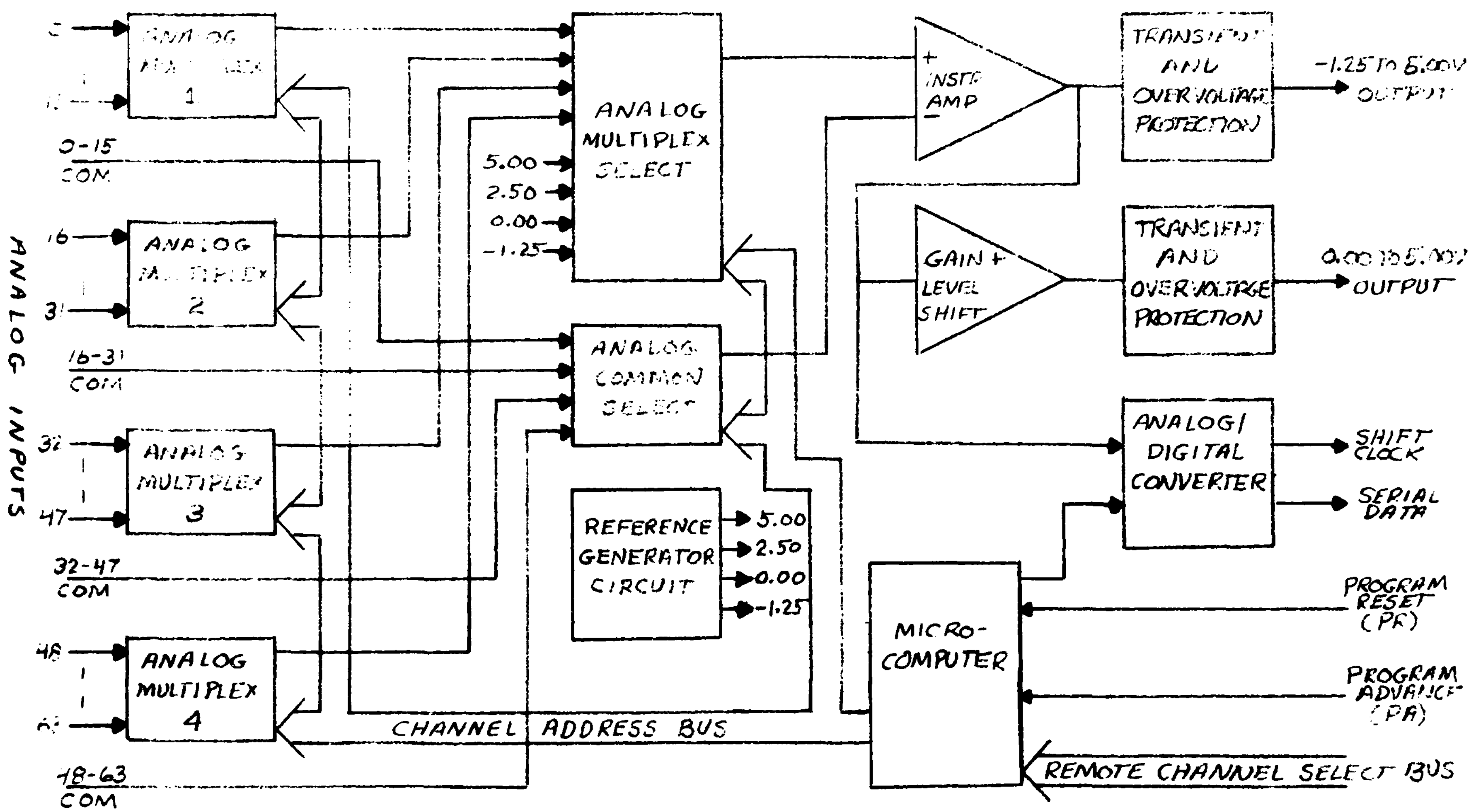
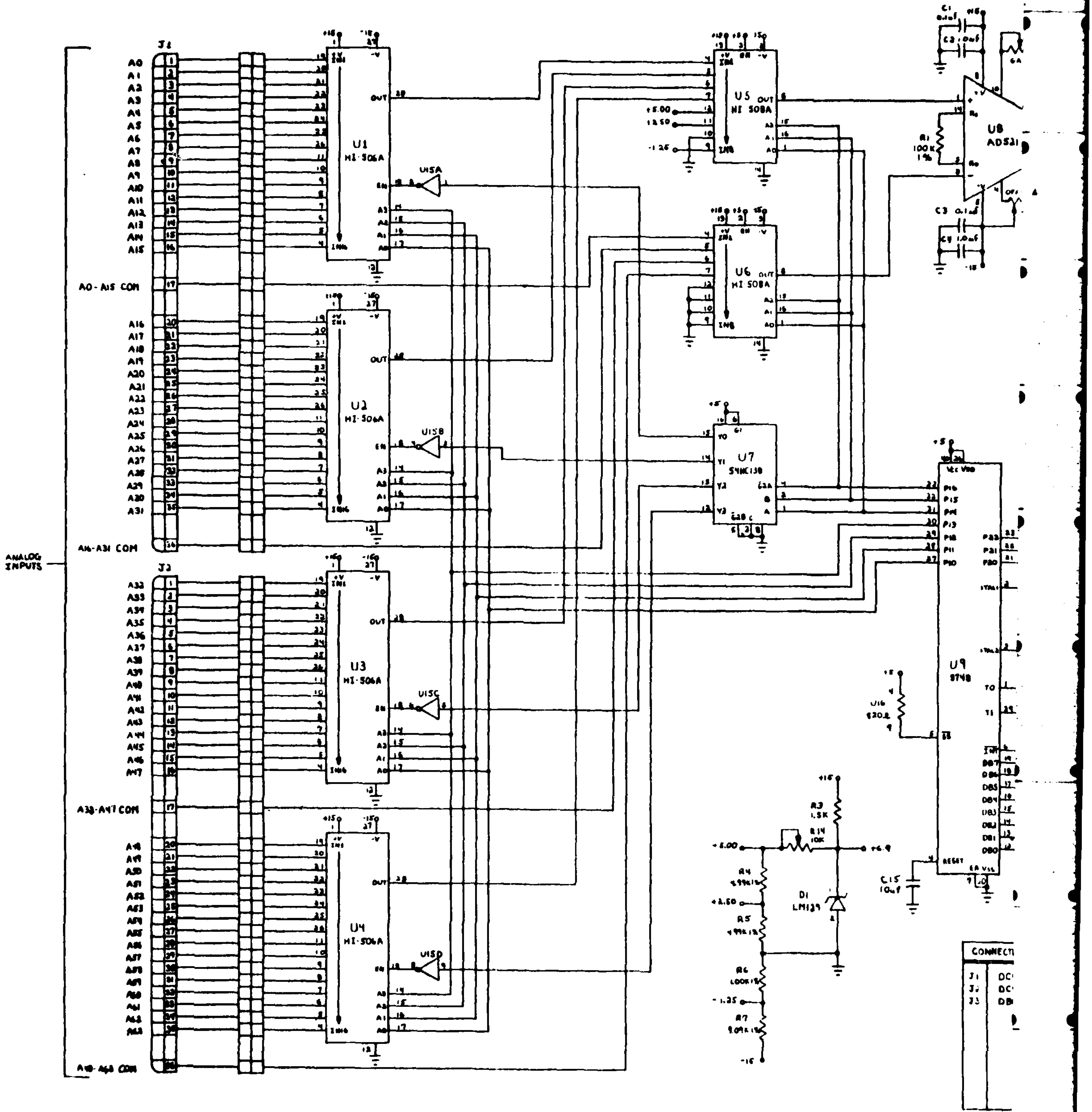
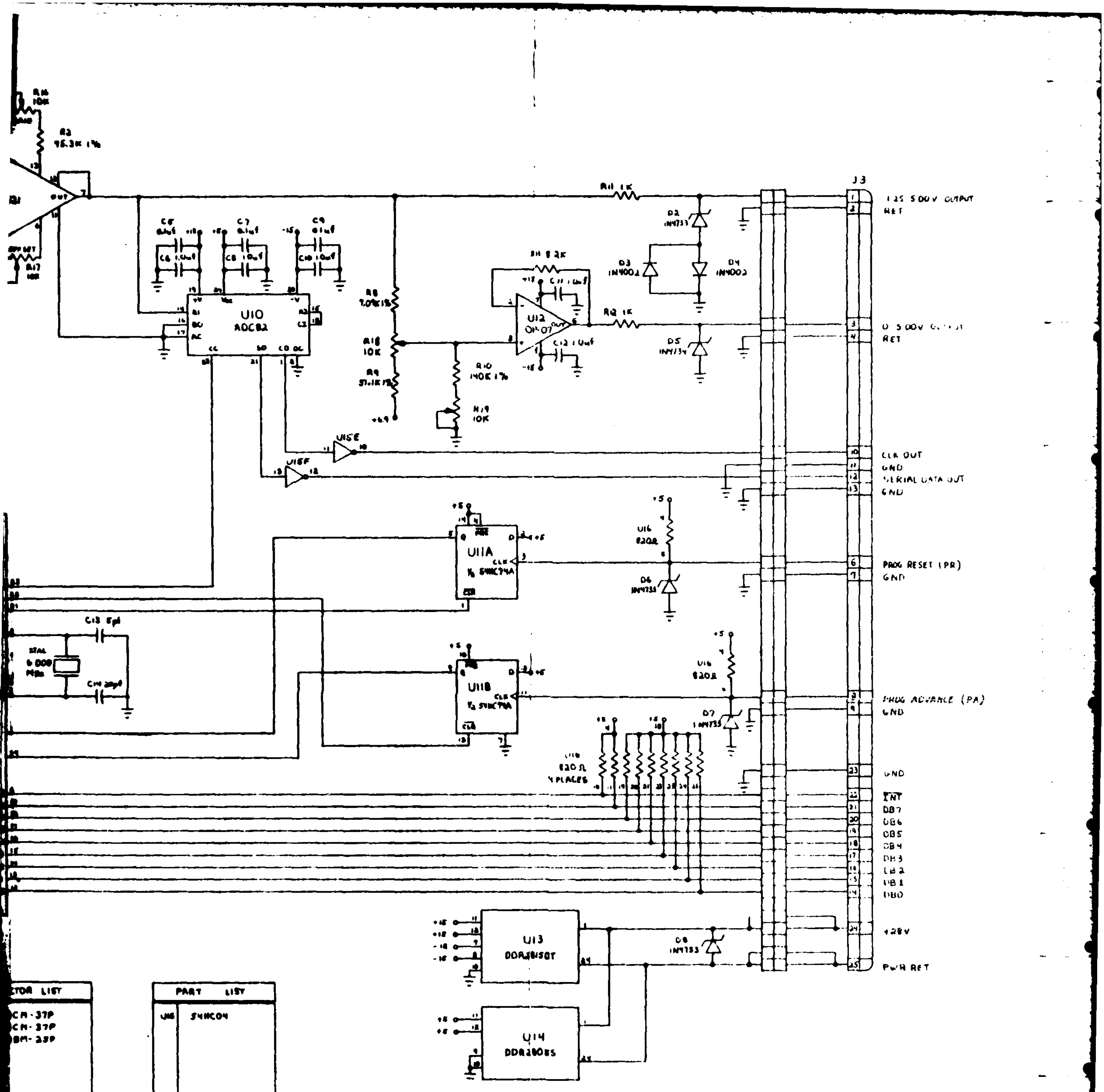


Figure 1. RDAS Block Diagram


ANALOG INPUTS
J1
J2
A0-A15 COM
A16-A31 COM
A32-A47 COM
A48-A63 COM
U1 HI-506A
U2 HI-506A
U3 HI-506A
U4 HI-506A
U5 HI 508A
U6 HI 508A
U7 54HC138
U8 AD521
U9 8748
U15A
U15B
U15C
U15D
R3 1.5K
R14 10K
D1 LM129
C15 10uF
CONNECT
J1 DC
J2 DC
J3 DB



...CTOR LIST
...CM-37P
...CM-37P
...BM-25P

PART LIST	
U16	54HC04

DRAWN	CHECKED	DATE
T.P. Wheeler	T.P. Wheeler	23 MAR 84

RDAS
REMOTE DATA ACQUISITION SYSTEM
SCHEMATIC

NORTHEASTERN UNIVERSITY
COLLEGE OF ENGINEERING
BOSTON, MASS 02115

ED5300

APPLICATION

2

have to be ordered). These two outputs have overvoltage and transient protection. These outputs are generated by a low impedance source and are designed to drive twisted shielded pairs. The third output is a serial digital bit stream produced by an analog to digital converter which is driven by the -1.25 to 5.00 volt output. (Signals below 0.00 volts are ignored by the converter). Accompanying the serial data is a shift clock which can be used to synchronously load a shift register with the serial data at a remote site, typically in the direct digital input section of a PCM encoder.

Inputs to the RDAS consist of 64 overvoltage and transient protected analog channels (0.0 to 5.00 volts), 4 analog common return line, 28V power and return, program reset and advance pulses and an 8 bit digital bus for remote channel selection.

The RDAS can be operated in 3 modes:

1.1 Self Clocking - In the self clocking mode, the advancement rate from one channel to the next (or to an internally generated reference voltage) is set by software control of a counter in the microcomputer, thus no external signals are required for operation in this mode. The format of the selected data channels and references is also programmed into the EPROM of the microcomputer. As an example, the format specified by IRIG for a RZ PAM commutator could be generated by programming the sequence to start with 3 successive 5.00 volt references, a -1.25 volt reference, a 2.50 volt reference, then alternate between the -1.25V reference and the desired complement of analog channels.

1.2 Remote Clocking - In this mode the advancement from one channel to the next is controlled by two remote digital signals, the program reset and the program advance (PR and PA respectively). The PR pulse

forces the program counter of the microcomputer to select the first channel of the output format. The PA pulse causes incrementation to the next channel in the format. Thus the PR pulse synchronizes the RDAS format to some external time reference (a particular channel in the PCM format, for instance) and the PA pulse determines when (and thus how fast) the incrementation takes place. Either the PAM or the digital serial data could be used as outputs in this mode. Normally, the PCM encoder would provide the control pulses and process the resulting data into the PCM bit stream.

1.3 Preflight System Check Mode - In this mode, a ground support test console circuit would temporarily be connected to the remote channel select bus. The control of timing and channel selection would then be passed from internal program to the ground support circuit. This would allow continuous monitoring of selected channels for performance verification and calibrations. It is also possible to completely control the RDAS for flight purposes via the remote channel select bus, as the channel selection of the microprocessor Port 1 follows the digital word placed on the remote channel select bus when the $\overline{INT}$ command line is low.

2. DETAILED CIRCUIT DESCRIPTION

The circuitry for the RDAS can be broken down into six sections:

2.1 Input Analog Gating - This section consists of four 16 channel analog multiplexers (U1 thru U4), an 8 channel analog multiplexer which selects one of the above multiplexers or one of the reference voltages (U5), an 8 channel multiplexer to select one of four signal common returns (U6), a 2 line to 4 line decoder (U7) and inverters (U15 A,B,C,D).

The above circuits are used to select a particular input data channel and its related return or one of the internally generated references.

This is done under control of the microcomputer via its Port 1 bus. The result of this selection is presented differentially to the instrumentation amplifier (U8). The 16 channel analog multiplexers are over voltage protected to 20 volts above the positive supply and 20 volts below the negative supply, as well as having transient protection to several hundred volts. This protection will prevent damage to the input gate in the event of signals being applied when the RDAS is unpowered.

2.2 Instrumentation Amplifier - The instrumentation amplifier (U8), is a high impedance, low offset, low noise amplifier. Its differential input configuration has a high common mode rejection which is effective in the suppression of common mode signals and noise on the data signals. Potentiometer controls (R16, R17) are used to set the gain to unity and offset to zero respectively.

2.3 Reference Voltage Generation - The reference voltages are derived from a precision zener diode (D1) which regulates at 6.9 volts. The 5.00 and 2.50 volts are produced from a resistive divider (R4, R5 and R14). The -1.25V reference is derived from the -15 volts supply through another resistor divider (R6, R7). These voltages, along with ground, are presented to U5 for selection as required.

2.4 Microcomputer - The microcomputer (U9) is an Intel 8748 with one kilobyte of EPROM selfcontained. The unit operates at a crystal frequency of 6 MHz. The microcomputer is programmed to the desired mode and format in a seperate programmer. In modes 1 and 2, the addresses of the data or reference voltages are read from the EPROM and outputted on Port 1. In mode 3, the addresses are taken from the remote channel select bus and transferred to Port 1. The PR and PA signals set a logic "1" into flip flops U11A and U11B respectively and these flip flops

are reset by the microprocessor after acknowledging their reception. The microprocessor also signals the analog to digital converter to start conversion at the proper time.

2.5 Output Circuits - The output circuits consist of the analog to digital converter (U10), and the two amplifiers (U8, U12). The analog to digital converter accepts signals from 0.00 to 5.00 volts and encodes them to an eight bit serial stream. This data stream along with a 9 bit synchronous clock pulses are outputted from the RDAS after buffering by inverters U15E and U15F. U8 is an instrumentation amplifier which drives the -1.25 to 5.00 volt PAM output as well as the analog to digital converter. U12 is a single ended operational amplifier used to condition the -1.25 to 5.00 volt signal to a 0.00 to 5.00 level. Both outputs of the amplifiers are overvoltage and transient protected, and are capable of driving a shielded twisted pair type cable for distribution of the PAM signals.

2.6 Power Supply - The power supply consists of two DC to DC converters which produce the ± 15 and +5 volts to operate the circuitry. Their input voltage is +28 ±4 volts and they are capable of producing ± 100 MA and ± 500 MA respectively. The outputs are regulated and are isolated from the input by up to 500 VDC.

3. PHYSICAL CHARACTERISTICS

The RDAS is housed in an anodized aluminum box (8.5 in. L x 4.0 in. W x 1.75 in. H) and weights 1.25 pounds. Analog data is inputted on two 37 pin D type connectors (DCM-37P) while outputs, digital signals, and power are placed on a 25 pin D type connector (DBM-25P). These connectors are located on one of the 4.0 in. x 1.75 in. faces of the box.

4. APPLICATIONS

The RDAS will be used on the BERT-I project, mounted at the top of the payload in the Mass Spectrometer Section where it will gather data from the electron guns, mass spectrometer and housekeeping functions. Due to the possibility of a very high noise environment, with unknown ground pulses generated by the on board experiments, the digital output format was selected for this project. The PCM encoder, at the other end of the payload will have optical isolators on all signals to and from the RDAS for further protection against noise and transients. The optical isolators chosen have a capability of blocking over 3000 volts.

Another RDAS will be used on the ERNIE payload. In this application, it will be used as a self clocking PAM encoder with its 0.00 to 5.00 volt output driving a subcarrier oscillator as part of a FM/FM communications link.

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J. Spencer Rochefort, Lawrence J. O'Connor, Norman C. Poirier and Thomas P. Wheeler, "Signal Encoding and Telemetry Systems for Space Vehicles," Final Report, Contract F19628-80-C-0050, May 1, 1983, AFGL-TR-83-0135, ADA134445.

PERSONNEL

A list of the engineers and student assistants who contributed to the work reported is given below:

J. Spencer Rochefort, Professor of Electrical and Computer Engineering, Principal Investigator.

Norman C. Poirier, Research Associate, Engineer.

Thomas P. Wheeler, Research Assistant, Engineer.

James B. Thurber, Project Assistant.

RELATED CONTRACTS AND PUBLICATIONS

AF19(604)-3506	1 April 1958 through 30 June 1963
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AF19628-71-C-0030	1 April 1971 through 31 March 1974
AF19628-73-C-0148	9 January 1973 through 30 April 1976
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AF19628-83-C-0037	4 December 1982 through present

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